Amendments to the Specification:

[0002]   Description of the Related Art. Vehicle headliners on the interior of an automobile are a decorative panel which separates the passenger compartment from the sheet metal forming the roof of the vehicle. The vehicle headliners absorb sounds from within the passenger compartment as well as sounds originating outside the passenger compartment. Soft fibrous materials are typically used for this function, but must be stiffened to give the headliners sufficient structural rigidity to avoid sag in service under all types of service conditions. It is further important that the overall thickness of the headliner be relatively small to maximize headroom within the vehicle compartment. In many applications, it is expected that the headliner will be sufficiently strong to support its own weight.

[0009]   According to the invention, a laminate for use in making a thermoformed article comprises first and second strengthening outer layers and a core layer between the strengthening layers. Each of the outer layers comprises a batt of nonwoven polymeric fibers. The outer layer provides the predominate flexural rigidity for the laminate and the core layer provides the predominate sound absorption for the laminate. The core layer batt preferably comprises a batt of nonwoven thermoplastic fibers having 20-50% fine fibers by weight, preferably with a denier in the range of 0.8-3.0less than 2.7, 10-50% binder fibers by weight, and the balance regularother fibers with a denier in the range of 4.0-15.0. Each of the strengthening layers comprises a batt of nonwoven polymeric fibers having less fine fibers by weight than in the core layer. The strengthening layers provide the predominant flexural rigidity for the laminate and the core layer provides the predominant sound absorption for the laminate. The thermoplastic fibers can include polyester, polyolefin, and nylon. The polyester fibers preferably include bicomponent fibers, such as a PET sheath-core bicomponent fiber. The core layer comprises regular fibers having a denier greater than the fine fibers of the core layer and in an amount to provide flexural rigidity to the laminate.

[0010]   The binder fibers preferably have a denier in the range of 0.8-200, with a preferred range of 3-25 denier. The core layer batt has a basis weight in the range of 6-24

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ounces/yd^{2}, with a preferred range of 6-12 ounces/yd^{2}. The core layer batt has a thickness of 0.5-2.0 inches, with a preferred thickness of 0.5-1.0 inches.

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[0017]   In another embodiment, the invention relates to a laminate comprising first and second strengthening layers and ~~an intermediate~~ a core layer disposed between the strengthening layers. ~~Each of the strengthening layers comprises a batt of nonwoven polymeric fibers.~~ The strengthening layers provide the predominate flexural rigidity for the laminate. ~~The laminate further comprises a core layer disposed between the strengthening layers.~~ The core layer provides the predominant sound absorption for the laminate. The core layer includes a batt of nonwoven thermoplastic fibers. The core layer batt ~~preferably~~ comprises 20-50% fine fibers with a denier in the range of 0.8-3.0, and 10-50% binder fibers, ~~and the balance regular fibers with a denier in the range of 4.0-15.0.~~ The first and second strengthening layers each comprise a batt of nonwoven polymeric fibers and the core layer has a resistivity greater than at least one of the first and second strengthening layers.

[0021]   ~~6~~ FIG. 1 illustrates a headliner 10 according to the invention. The headliner 10 has improved sound absorbing properties in combination with structural rigidity, while maintaining a relatively thin cross-section. The headliner 10 accomplishes the sound absorbing function while maintaining sufficient structural rigidity to avoid bowing or sagging when exposed to heat and is capable of supporting at least its own weight. The headliner 10 accomplishes this result without undue thickness, which would undesirably reduce the available headroom in the passenger compartment of the vehicle and without undue density ~~which~~ that would decrease vehicle fuel efficiency.

[0023]   The core layer 12 comprises a batt of a blend of nonwoven fibers, including fine denier fibers, regular denier fibers, and binder materials, which preferably includes binder fibers
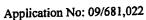
with a lower melting point fiber component. The denier of the fibers in the core layer can vary over a wide range but generally will be in the range of 0.8 to 200, denier, and preferably in the range of 0.8 to 15 denier. Preferably the core layer contains 20-50% by weight (all composition percentages are by weight unless otherwise noted) of fine fibers in the range of approximately 0.8 to 3 denier, θof fibers in the range of approximately 4 to 15 denier, and 10-50% binder fibers. At least some of the binder fibers can be the fine denier fibers and the regular denier fibers, especially if either of these fibers is a bicomponent fiber having a high melting point core and a low melting point sheath, such as is found in U.S. Patent No. 4,195,112 to Sheard. The binder fibers can also be a blend of high and low melting point thermoplastic fibers.

[0030]   The web adhesive layers 20, 22 are preferably a sheet of nonwoven thermoplastic fibers having interstitial spaces between the fibers. The fibers are preferably co-polyester. The web adhesive is advantageous or the prior techniques for bonding together the laminate layers, such as a liquid adhesive or liquid resin, ~~for bonding together the laminate layers~~ because the web adhesive does not fill in the interstitial spaces between the fibers at the interface between the laminate layers but forms a fiber to fiber bond, thereby increasing the bond without substantially decreasing the sound reflectance of the laminate. A suitable web adhesive is PE2900 manufactured by Spunfab, Ltd. Of Cuyahoga Falls, OH.

[0042]   From table 2 it can be seen that even though Sample 2 with the fine fibers hasa two-thirds the mass to absorb sound, it still absorbs a similar percentage of sound over the tested range compared to that of the Standard Substrate, and it has a slightly better performance at the lower frequencies and slightly worse performance at the higher frequencies. Therefore, the core layer according to the invention, as illustrated by Sample 2, provides generally better sound absorption in the lower frequency range for a given thickness, but at a reduced weight. The reduced weight places less load on the headliner and helps to reduce the vehicle weight, which are advances over prior headliner constructions.

[0043]   Table 3 illustrates the ASTM C423 sound absorbing properties of a laminate with I-beam construction comprising the core layer 12 and the stiffening layers 14 and 16 (Sample 3)

as compared to a single layer (Single Layer 2) of sound absorbing material at a given basis weight and thickness. Sample 3 comprises a core layer weighing 12 ounces/yd ^{2} with a fiber blend of 50% Wellman 6, 35% Wellman 0.9 denier PET staple fibers (Wellman 0.9), and 15% Wellman 4.75. Sample 3 also includes stiffening layers 14 and 16 weighing 12 ounces/yd ^{2} and comprised of 20% Wellman 15, 50% Wellman 6, and 30% Unitika 4. Single Layer 2 is actually three layers of the same material. Each layer weighs 12 ounces/yd ^{2} with a fiber blend of 100% Talon 6 denier mixed reclaimed synthetic fibers (Talon 6). The Talon 6 material has a denier in the range of 3-15 denier. The average denier is 6. The overall basis weightis of Single Layer 2 is 36 ounces/yd ^{2}.

[0054]   Table 4 includes three known previous laminate constructions identified as Prior 1, Prior 2, and Prior 3. Prior 1 and Prior 2 have an overall basis weight of 52 ounces/yd ^{2} and an overall composition that does not include a heat resistant thermoplastic binder. The core layer of Prior 1 and 2 each has a basis weight of 20 ounces/yd ^{2} and a fiber blend of 80% Martin 3 denier and 20% Wellman 4.75. The stiffening layers of Prior 1 and Prior 2 each have a basis weight of 16 ounces/yd ^{2} and a fiber blend of 65% chopped fiberglass roving, 28% phenol-formaldehyde thermoset binder, 4% polyester spunbound scrim, and 3% polyethylene film.

[0069]   It is within the scope of the invention for the core and outer layers to contain the same type of fibers, but not to the detriment of the respective predominate functions provided by the core layer and the outer layers. Care must be taken to make sure that the fiber mix, i.e., the percentage of each type of fiber in the layer, in either the core and outer layers does not impair the primary sound absorbing function of the core layer or the primary strength function of the outer layer.